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Forest Pest Management
Pacific Northwest Region

FOREST PEST EVALUATION

WEST RED PLANNING AREA

CLE ELUM RANGER DISTRICT

WENATCHEE NATIONAL FOREST

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WENTACHEE NATIONAL FOREST

by

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INTRODUCTION

On August 21, 22, and 26 through 29, 1985, Forest Pest Management personnel did a forest pest survey of stands in the West Red Planning Area (T. 21 N., R. 16 E., sec. 13, 24 and 25; T. 21 N., R. 17 E., sec. 18, 19, 30 and 31; T. 20 N., R. 17 E., sec. 5 and 6). The Planning Area includes about 3800 acres (Figure 1). Purposes of the evaluation were to identify pests damaging selected stands, identify problem areas, and develop management recommendations aimed at minimizing current and future losses. The evaluation was requested by Robert Mrowka, District Silviculturist, for use in developing management plans and alternatives for the proposed 1988 West Red Timber Sale.

SITE AND STAND CHARACTERISTICS

A variety of stands occur in the area examined; tree species include Douglas-fir, western larch, grand fir, subalpine fir, lodgepole pine, ponderosa pine, and Engelmann spruce. All ages are represented. Many stands have been entered. Most have been partially cut although several plantations resulting from past clearcuts are present. Partial-cutting practices resulted in the removal of a high percentage of the more valuable species, especially ponderosa pine, Douglas-fir, and larch.

The West Red area lies directly west of Teaneway Ridge. Westerly aspects predominate. Topography is moderate to steep, with slopes ranging between 40 and 70 percent; gentler slopes occur on the numerous benches and saddles. Elevation ranges between 3600 and 5300 feet.

METHODS

Stands in the Planning Area were delineated and reconnoitered by a contract crew prior to our survey. We inspected stands selected from the total of 29 that had been identified by the contractors. Walk-through inspections were made in 14 of these stands. No specific criteria were used in selecting stands for inspection. We attempted to visit, within time constraints, stands through-

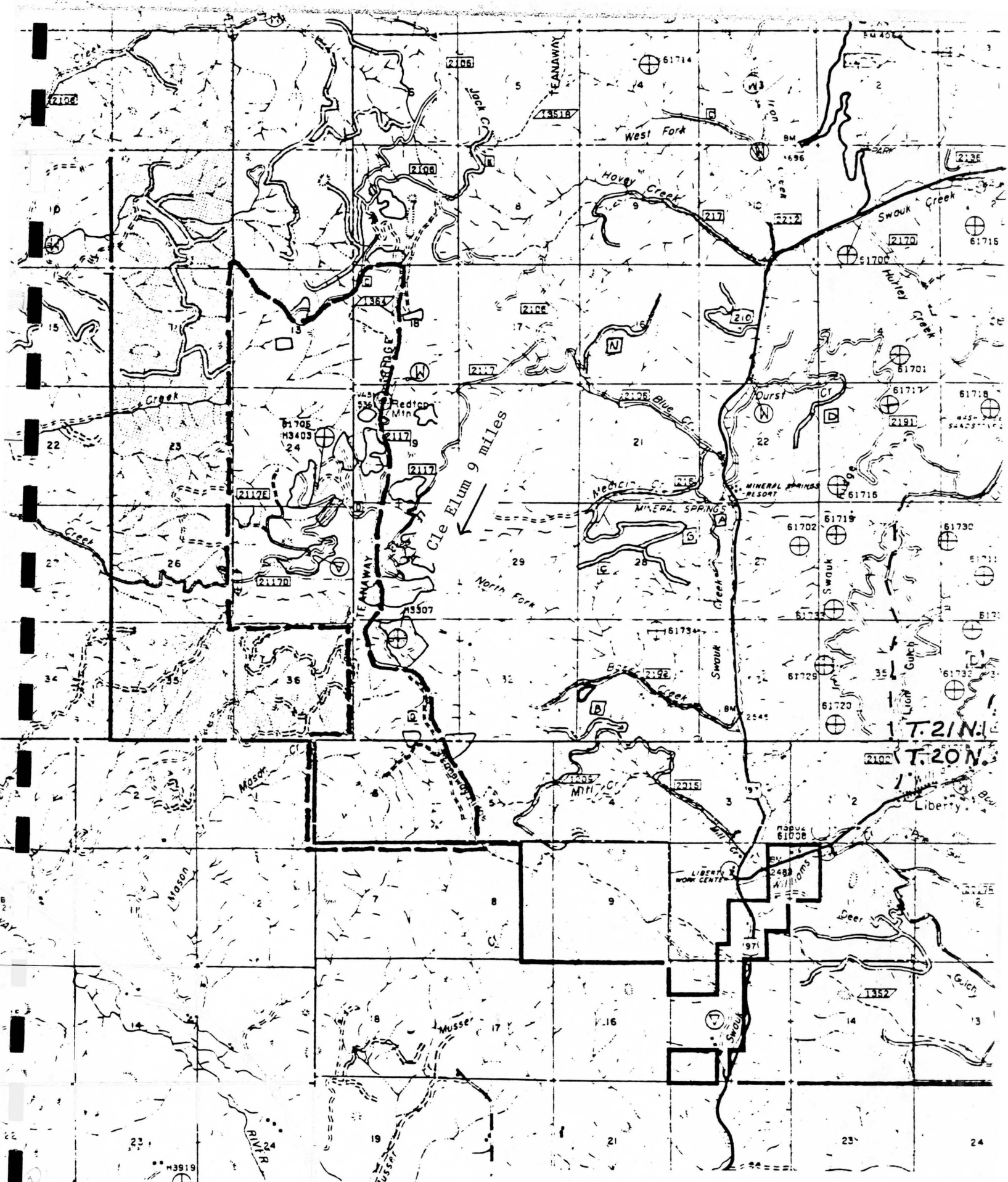

Figure 1. Vicinity Map of the West Red Planning Area

out the Planning Area, especially those with the highest suspected level of pest-caused damage.

Stands were inspected by walking through portions believed representative of the block. When possible, we tried to view stands from superior vantage points to pinpoint problem areas that could be visited. In most cases, we located the flag line placed by the reconnaissance contractors and traveled a portion of its length.

Stands were examined for evidence of pests and pest-caused damage. Nonstocked or understocked portions of stands were scrutinized for evidence of root diseases. Symptoms of damage included root balls on dead, down trees; old stubs; recently killed, standing trees; and live trees exhibiting fading and declining crowns. Dead trees and live trees exhibiting symptoms of root diseases were examined to determine the causal pest. This involved (a) removing a section of bark from the boles of dead trees to check for bark beetles or their galleries, and (b) removing a section of bark on one or more sides of the root collar; exposing and dissecting portions of one or more large roots to check for stained or decayed wood or mycelium of root disease fungi.

Disease incidence and severity of damage were rated at three levels; a rating of 1 (one) was given if disease severity was minor; a 2 (two) was given for moderate severity; and a 3 (three) was given for severe damage. A rating of (1) suggests that when the stand is entered in the normal course of events, this pest problem should be recognized and controlled within the framework of the selected silvicultural system. A damage rating of (2) suggests that the stand may need to be entered. The specified-pest problem should be considered when formulating and selecting management options. A rating of (3) indicates that the stand needs to be entered with silviculture and management systems specifically selected to minimize current and future damage caused by that pest.

RESULTS

Observation summaries are listed by stand at the end of this section. The location of individual stands within the planning unit is not included in this report. This information is on photo overlays at the Cle Elum Ranger District.

Several pest problems were observed in the West Red stands. In many areas, pest problems, especially root diseases and dwarf mistletoes, were causing severe losses. Other less common and damaging pests included bark beetles and stem decays. Western spruce budworm (Choristoneura occidentalis) feeding was seen in some areas. Populations of this insect are increasing in the West Red Planning Area and defoliation may be readily visible in susceptible stands within two or three years.

Reconnaissance report summaries of stands not visited were reviewed for mention of disease incidence. This information is included in Table 1.

Table 1. Incidence and Severity of Pests in West Red Planning Area, Cle Elum Ranger District

Stand Number	PEST#								
	Pw	Fa	Ao	Ps	DF DM	WL DM	LPP DM	MPB	Et
50*				1			1	1	
51									
52*	3	1	1	1	2	2			
53									
54					(x)				
55					(x)				
56					(x)				
57*	2	2		2	2	1			2
58	(x)					(x)			
59									
60*	2				1	1			
61									
62									
63*	1			2	(x)				
64									
65					(x)				
66*	3				3				(x)
67					(x)				
68*	1	1			3	3			
69					(x)				
70*	2	(x)			2	2			(x)
71					(x)				(x)
72*									
73									
74*		2			(x)				2
75*	3				3	3			
76*					1				
77*	2	1			1				1
78*	3				3	3			

NOTE: # - Pw: laminated root rot, caused by Phellinus weirii
Fa: Annosus root disease, caused by Fomes annosus
Ao: Armillaria root disease, caused by Armillaria ostoyae
Ps: Schweinitzii root disease, caused by Phaeolus schweinitzii
DF DM: Douglas-fir dwarf mistletoe (Arceuthobium douglasii)
WL DM: larch dwarf mistletoe (Arceuthobium laricis)
LPP DM: lodgepole pine dwarf mistletoe (Arceuthobium americanum)
MPB: mountain pine beetle (Dendroctonus ponderosae)
Et: decay caused by Indian paint fungus (Echinodontium tinctorium)
* - stands visited by FPM crew
1 - disease and damage level is minor
2 - disease and damage level is moderate
3 - disease and damage level is high
(x) - pest probably present as indicated from reconnaissance report.

STAND NUMBER- West Red 050

Brief Stand Description:

Overstory Species - LPP, and a few large WL and DF, especially in the lower (western) portion of the stand.

Understory Species - LPP, GF, and minor WWP.

Stand Condition: Mature to overmature, overstocked, and stagnated LPP predominates in the upper (eastern) portion of this stand. The DF component increases in the lower portion of the stand.

Pest Situation: Minor amount of Schweinitzii root and butt rot in overstory DF and LPP. This has caused a minor amount of breakage and windthrow of individual trees. Very minor dwarf mistletoe (DM) in LPP. Mountain pine beetle-caused mortality was minor in LPP. Pests are not currently causing significant damage.

Other Comments: This stand is susceptible to mountain pine beetle damage due to stand age and structure. We disagree with the "pre-fire" root rot statement in the reconnaissance report which states that the stand had a high incidence of root disease prior to the last major fire.

Management Alternatives: Recommend WL seed tree or mixed WL/LPP shelterwood with subsequent stocking control. Highest productivity will be towards LPP, WL.

STAND NUMBER- West Red 052

Brief Stand Description

Overstory Species- DF, WL, GF, SAF

Understory Species- GF, SAF, DF, WL

Stand Condition: Overstory is overmature. Disease problems are severe in several areas.

Pest Situation: Laminated root rot is severely damaging DF, WL, and GF in pockets towards the west end of the east segment of stand. Similar damage is also occuring in the north portion of the west segment. Minor to moderate Annosus root disease and Armillaria root disease were found affecting true firs throughout most of the remainder of the blocks. Severe DF DM was found in one small area toward the west middle portion of the west segment of this stand. WL and DF DM were found at moderate to severe levels in the north part of the west segment of this stand. Some Schweinitzii root rot was found in DF, WL and true firs.

Other Comments: We disagree with the statements made on the extent of DM infestation in this stand. No DM was found in the east segment of this stand.

Management Alternatives: Some regeneration-type silviculture treatment is needed. In this stand WWP may be a preferable species. White pine blister rust hazard determination should precede selection of WWP stock for planting. WL may be grown for short rotations (less than 100 years).

STAND NUMBER- West Red 057

Brief Stand Description

Overstory Species- DF, GF, WL, WH, PP

Understory Species- GF, SAF, WH, DF, WWP

Stand Condition: This stand is deteriorating. Overmaturity and numerous disease problems make this stand a high priority for treatment.

Pest Situation: Laminated root rot was found near the eastern portion of this stand. It is probably present in other areas. DF and SAF were most severely affected. WL appeared to be more resistant. Schweinitzii root rot was found damaging DF and true firs in the east-central portion of the stand. DM was found affecting DF and WL, the latter only in the western portion of stand. Older true firs were also damaged by Annosus root disease and Indian paint fungus.

Other Comments: Root disease centers should be identified on the ground prior to post-harvest treatment.

Management Alternatives: Recommend a regeneration-type system. DF should be grown in areas unaffected by laminated root rot. WL and WWP should be managed in laminated root rot pockets. Blister rust hazard determination should precede selection of WWP stock for planting.

STAND NUMBER- West Red 060

Brief Stand Description

Overstory Species- GF, DF, WH, WL

Understory Species- GF, WH

Stand Condition: We walked through the portion above (SE) and along Road 242. This is an older, deteriorating stand.

Pest Situation: Laminated root rot is affecting DF and GF in the portion of the stand southeast of Road 242. WL in this portion of the stand appears healthy. Minor DM was found in overstory WL and DF in the portion of the stand adjacent to Road 242.

Other Comments: Laminated root rot centers should be located on the ground prior to regenerating this stand.

Management Alternatives: Recommend a regeneration harvest. Clearcut with artificial regeneration or possibly a WL seedtree system. Regenerate root diseased areas with non-susceptible species.

STAND NUMBER- West Red 063

Brief Stand Description

Overstory Species- DF, GF

Stand Condition: The south half of this stand was examined. This stand is very decadent. Numerous areas with exposed rock and shallow soils occur.

Pest Situation: Schweinitzii root and butt rot was found throughout stand. DF was most seriously affected. Infection appeared associated with numerous fire scars on older overstory trees. DF was not infected with DM in the southern portion of the stand although it is reported in the northern portion by the contractors. Laminated root rot was found in a small area in the central portion of stand. An unspecified root rot was reported in the northern portion.

Other Comments: This stand should be given a high priority for treatment.

Management Alternatives: Recommend a regeneration harvest. Regenerate to DF and possibly PP. Laminated root rot areas should be planted exclusively to PP.

STAND NUMBER- West Red 066

Brief Stand Description

Overstory Species- DF, PP, GF

Understory Species- GF, DF

Stand Condition: This stand has been heavily thinned in the recent past. The current stand is in poor condition.

Pest Situation: Laminated root rot was found; most commonly on north-facing slopes. DF is severely infected with DM in this same area.

Other Comments: Areas affected by laminated root rot should be delineated on the ground when this stand is treated.

Management Alternatives: Recommend a regeneration harvest. In areas free of DM and laminated root rot a DF/PP shelterwood is a viable option. PP should be managed in root-diseased areas and DF can be grown in other areas if sources of DM infection are removed.

STAND NUMBER- West Red 068

Brief Stand Description

Overstory Species- DF, PP, WL, GF

Understory Species- GF

Stand Condition: Most of this stand was inspected. Overstory trees are in poor condition. PP is old and no longer producing seed. The understory of GF is vigorous and healthy. In at least portions of this stand advance regeneration of GF could be managed.

Pest Situation: DM is severe in DF. Almost all trees are infected. Most WL are also infected with DM. Laminated root rot was found in one area affecting GF and WL. Annosus root disease was also found killing GF. Both of these root diseases were found at low levels and damage was minimal.

Other Comments: Only GF has been regenerating. To establish vigorous seral species, this stand would have to be clearcut.

Management Alternatives: Recommend an overstory removal along with a commercial thinning of the overstocked portions of stand. Manage the resulting stand of GF until maturity. A regeneration harvest and planting of DF, PP and WL would then be possible.

STAND NUMBER- West Red 070

Brief Stand Description

Overstory Species- GF, DF, WH, WL

Understory Species- GF, DF, WH

Stand Condition: Stand was partially cut 8 to 10 years ago. High value species were taken leaving mostly true firs. Considerable scarring of residuals occurred. The eastern portion of this stand is slightly more vigorous than the western portion although diseases are causing high losses. In the west side this stand contains a higher proportion of WH which is mostly stagnated.

Pest Situation: Several centers of laminated root rot were found affecting DF and GF in the eastern half of stand. WL was not being affected. Some DF and WL DM were found towards the west end of the eastern portion of stand.

Other Comments: The eastern portion of this stand is marginal. It could be treated now or deferred. If entered now some GF advanced regeneration could be saved. Portions of stand worth saving may not be large enough to manage. The western portion of stand is ready to be regenerated.

Management Alternatives: West side of stand should be clearcut and regenerated to DF and WL. The east may be deferred or treated during this next entry by clearcutting and regenerating DF, WWP, and WL. Avoid putting DF into laminated root rot pockets. Some vigorous advanced GF regeneration not threatened by root disease might be managed. If WWP is used, a blister rust

hazard evaluation should be made prior to selecting planting stock for resistance.

STAND NUMBER- West Red 072

Brief Stand Description

Overstory Species- GF, DF, SAF

Stand Condition: This is a young, fairly vigorous, although overstocked stand of predominantly DF, GF, and SAF. This stand had a light partial cut in the past.

Pest Situation: Dwarf mistletoe was mentioned in the reconnaissance report but was not observed in our evaluation. No other pest problems were observed.

Management Alternatives: This stand does not have a high priority for treatment. An entry could be deferred for 15 or 20 years, or a commercial thinning leaving DF as residuals could done.

STAND NUMBER- West Red 074

Brief Stand Description

Overstory Species- DF, GF, PP

Understory Species- GF, DF

Stand Condition: Overmature, partially cut, with a large component of decadent GF. DF DM was reported but not observed by the FPM crew. Advance regeneration was spotty or non-existent over most of the area.

Pest Situation: Indian paint fungus-caused decay is present in some of the older GF. Armillaria root disease was found killing GF in several pockets. The decadence of the overmature GF will keep this stand from being very productive.

Other Comments: High treatment priority.

Management Alternatives: Patch clearcut portions and regenerate to DF, WL, and PP.

STAND NUMBER- West Red 075

Brief Stand Description

Overstory Species- DF, GF, WL, PP, WH

Understory Species- GF

Stand Condition: High-graded. Scarring of residuals was widespread and severe. Leave trees are in general poor condition. There is a dense GF understory which is probably not manageable because of its condition.

Pest Situation: Severe laminated root rot was observed in DF and GF. Severe DM in most DF and some WL.

Other Comments: High treatment priority.

Management Alternatives: Clearcut with regeneration to WL and PP. Douglas-fir may be managed in areas not affected by laminated root rot.

STAND NUMBER- West Red 076

Brief Stand Description

Overstory Species- DF, PP, GF

Understory Species- PP, DF, GF

Stand Condition: Partially cut about 10 years ago. Healthy and vigorous. An overstory of predominantly mature DF and PP. Clumpy understory of DF and PP.

Pest Situation: A minor amount of DF DM was found. Reconnaissance contractors report high defect in larger GF.

Other Comments: This stand is more vigorous than reported by reconnaissance contractors.

Management Alternatives: Recommend a commercial thin from below, retaining the best DF and PP. A second option would be deferring treatment until the healthy vigorous understory is merchantable.

STAND NUMBER- West Red 077

Brief Stand Description

Overstory Species- GF, DF, PP

Understory Species- GF, DF, WH

Stand Condition: This stand had been partially cut in the past with DF and PP being preferred. GF currently predominates in the overstory.

Pest Situation: DF DM was observed but considered not serious. Reconnaissance contractors state that they observed a higher level of infection than was seen by the FPM crew. This may have been in areas that we did not visit. Laminated root rot is present and level of damage was moderate. Indian paint fungus was also noted. This and possible Annosus root disease make successful continued management of GF questionable.

Other Comments: High treatment priority.

Management Alternatives: A regeneration cut with DF, WL and PP being regenerated would be preferred. Laminated root rot pockets should be identified and regenerated to a PP, WL mix.

STAND NUMBER- West Red 078

Brief Stand Description

Overstory Species- DF, GF, WL

Understory Species- GF, DF, WWP

Stand Condition: Old partial cut (high graded). Scarring of residuals is extensive.

Pest Situation: Pest-caused damage is severe. Laminated root rot is causing severe losses. DF and GF are being affected. DM is severe in almost all DF and most WL.

Other Comments: High treatment priority.

Management Alternatives: Regenerate to DF, WL, WWP, and PP. Root rot pockets should be identified on the ground and regenerated to WL, WWP, and PP; PP could be used on harsher sites and WWP on the less severe sites. A blister rust hazard survey should be made prior to selection of WWP for planting.

Pest Biology and Identification

DWARF MISTLETOES

Dwarf mistletoes (Arceuthobium sp.) are obligate plant parasites. Most members of this genus have specific host preferences i.e., they commonly attack only one or two coniferous species. Dwarf mistletoes spread by seeds forcibly ejected from capsule-like berries during late summer and fall. Average seed dispersal distance varies considerably by mistletoe species. Following interception of seed by conifer foliage, a new mistletoe plant will develop and mature, producing seeds in 4 to 5 years.

Dwarf mistletoes affect their host by diverting water, nutrients and photosynthates which would normally be assimilated. As a result, severely infected trees suffer loss of vigor and reduction in growth. Impact varies between species. In most host species, spindle-shaped swellings and "broomed" branches form several years after infection. Other forms of damage include product degrade, top-killing and mortality. Secondary mortality-causing agents often attack and kill trees weakened by dwarf mistletoe infections.

Dwarf mistletoe-infected trees can usually be identified by "witches'-brooms". Caution is advised when using brooms as the only diagnostic evidence for infection; other agents do cause brooming also. Positive identification can be made by finding aerial shoots of the mistletoe, especially on swellings. Dead detached shoots may sometimes be found under infected trees. When plants cannot be found on swellings, the presence of "basal-cups", indicating locations of past shoot attachment to the branch, can usually be found.

Douglas-fir Dwarf Mistletoe

Tree mortality is commonly associated with Douglas-fir dwarf mistletoe (A. douglasii). Trees with large brooms suffer severe growth loss. Top-kill and degrade are common results of infection. Seed dispersal distance averages about 10 feet; as a result, spread through stands is slow. Additionally, extent of latent infections is not far beyond visibly infected trees.

Douglas-fir dwarf mistletoe-infected understory stands frequently are unmanageable. Infected stands that currently appear more than 20 years from merchantability may not be worth saving because of projected impact. Attempts to thin infected stands usually result in enlargement of infections and activation of numerous latent infections.

Western Larch Dwarf Mistletoe

Western larch dwarf mistletoe (A. laricis), causes growth loss and mortality to its host. Suppressed trees and trees growing on poor sites are in the greatest danger of being killed since their slow height growth allows the dwarf mistletoe to spread quickly to the upper crown. Witches'-brooms usually develop on infected branches which die and break off with time, leaving the tree with little more than small tufts of branches for a crown. Trees in this condition usually die within a few years. Mistletoe-infected trees often develop large cankers and abnormal stem growths. Along with reduced growth and increased mortality rates, severely infected larch have reduced cone and seed yield.

Lodgepole pine may be infected by larch dwarf mistletoe at a rate high enough to be a management concern. Instances of this occurring have usually been in stands where pine is below an infected larch overstory.

Lodgepole Pine Dwarf Mistletoe

Lodgepole pine dwarf mistletoe (A. americanum) causes dramatic growth loss in severely infected trees. Mortality does occur but not as frequently as in Douglas-fir and western larch. Large brooms form in infected trees. As a result, trees are frequently deformed.

Since most lodgepole pine stands originate following fires, most mistletoe infestations start around infected surviving residuals.

ROOT DISEASES

Laminated Root Rot

Laminated root rot, caused by Phellinus weirii, is a common disease of mixed-conifer stands in the Northwest. Damage occurs as premature tree death and loss of stocking on diseased sites. Phellinus weirii rarely, if ever, spreads by spores. Instead, it persists on sites in infected woody material in the soil. The fungus can survive in large roots of stumps and snags for 50 years or more. Spread occurs when roots of healthy trees contact viable inoculum and become infected. Disease centers can expand at rates of 1 to 2 feet annually.

Laminated root rot causes tree and stand symptoms similar to other root diseases. Disease centers are recognized by the prevalent occurrence of dead standing and windthrown trees. Usually there will be evidence of more recent mortality towards the periphery of the center. At edges of the center, live symptomatic trees may be found. These may display one or more crown symptoms including reduced height growth, thinning foliage, chlorotic foliage, and abnormally large crops of smaller than normal cones. More specific symptoms are also apparent. Dead and down trees will usually have decayed remnants of the root system, called a "root ball". Decayed wood will have typical laminated wood decay that separates at the annual rings. Between delaminating sheets, sterile fungal mycelia called setal hyphae may be found. These appear as reddish-brown whiskers. Delaminated sheets of wood will usually be pitted on both sides. These characteristic pits are approximately 2 mm long and 1 mm wide. The disease can be identified on recently-killed and live-infected trees by the occurrence of ectotrophic mycelium on the exterior surface of infected roots. Ectotrophic mycelium appears as a grayish, crusty, fungus growth. It spreads on the surface of root systems, later penetrates the bark and attacks woody tissue.

Considerable variation in susceptibility exists among Northwest conifers. The most susceptible species include Douglas-fir and grand fir. These species often die or are windthrown once roots are decayed, though mature infected trees often live indefinitely with decay in their root systems. Intermediately susceptible species include western larch, western hemlock and Englemann spruce; which are not readily killed by P. weirii. They may become infected if they are growing in close association with susceptible species, and damage will

often be restricted to butt decay. These species can be used to regenerate disease centers without suffering major losses. In several stands in the West Red area, western larch is severely affected by laminated root rot, appearing more prone to damage than would be normally expected for the species. In other stands it was not being affected as seriously. Trees tolerant to P. weirii include western white pine and lodgepole pine. These species can grow in close association with susceptible species and seldom be damaged, although they may be infected. Trees resistant to P. weirii include ponderosa pine and western redcedar. While a butt rot caused by P. weirii is common in western redcedar in the Inland Empire, a root disease caused by this fungus seldom occurs on this species. All hardwoods are immune to infection.

Armillaria Root Disease

Armillaria root disease is caused by Armillaria ostoyae. This is the same fungal pathogen that had been known in the Northwest as Armillaria mellea. Recent taxonomic work indicates that several species of Armillaria exist and A. ostoyae is the species that attacks Northwest conifers.

Armillaria root disease occurs in disease centers similar to laminated root rot. It is also frequently found attacking single trees or small groups of trees. Windthrow of living trees does not often occur. Live infected trees will produce typical root disease symptoms. Individual infected trees can be identified by characteristic cream-colored mycelial fans which grow under the bark of infected roots. Resinosis is also common around the base of infected trees, especially where mycelial fans are under the bark. Black, string-like fungal structures called rhizomorphs are frequently found on root surfaces of infected trees and under the bark of trees that have been dead for several years. Decay caused by A. ostoyae is characterized as being a uniform white spongy rot with numerous black zone lines.

Armillaria ostoyae is a very effecient saprophyte that survives in stumps, roots, and other buried woody material. The fungus can infect living trees across root contacts or by growing short distances through the soil via rhizomorphs. Under most conditions, A. ostoyae is a rather weak pathogen that mainly infects and helps kill stressed, overmature, or injured trees. Sometimes the fungus can become very aggressive, forming large active disease centers. Damaged, stressed trees growing on disturbed sites are often severely affected by Armillaria.

Annosus Root Disease

Annosus root disease, caused by Fomes annosus is a serious pest of true firs in many mixed conifer stands. Damage, including root rot and butt decay, is most common in stands that have been previously entered. The fungus is spread by windborne spores, which infect wounds and fresh-cut stump surfaces. The disease becomes established when spore infections successfully colonize stumps and trees. Spread can then occur across root contacts and grafts between infected material and healthy trees. Infection centers will frequently be found that have developed around old stumps. Stumps less than 18 inches in diameter do not appear to present a hazard as an inoculum source. Fruiting bodies of F. annosus can often be found inside decayed old true fir stumps.

Annosus root disease also affects pines in some East Side stands. Apparently, different strains of the fungus infect different species. Pines are not

affected when they are growing within an annosus root disease center affecting true firs.

Annosus root disease can be difficult to identify in some cases. This is because characteristic signs and symptoms are not always present. Laboratory testing of suspect infected material can verify field diagnosis. Dead and dying true fir infected with F. annosus will usually have a brown-to-reddish stain with uneven margins or a white, stringy to somewhat laminated decay with black flecks in the roots or root collar. The occurrence of F. annosus conks within stumps surrounded by dead and dying trees is a strong indicator of annosus root disease.

Schweinitzii Root and Butt Rot

Schweinitzii root and butt rot, caused by Phaeolus schweinitzii, is a pest which most seriously damages pines, Douglas-fir, and western larch. It is most commonly found as a butt rot problem in older trees. It less commonly causes a tree-killing root rot in young trees. Damage is often associated with fire scars.

Infected trees usually remain alive, not displaying obvious crown symptoms. Mortality may occur as windthrow or windbreak induced by advanced decay. The wood decay is a dry, crumbly, brown cubical rot.

Fruiting bodies of the fungus may grow from the lower bole but more frequently emerge from the duff directly above infected roots.

Other Pests

Indian Paint Fungus

The Indian paint fungus, Echinodontium tinctorium, causes the most serious heartrot of live true firs on the East Side. Advanced decay is a brown-colored white rot which occurs in the heartwood of infected trees. Severely infected trees are often reduced to hollow stems.

Trees most susceptible to damage have been identified as having the following characteristics:

1) mature to overmature
2) originated under an infected true fir overstory
3) have been suppressed for 50 years or longer
4) have been wounded

Spread of the disease is via airborne spores which infect freshly exposed branch traces on susceptible hosts. Following infection, the fungus may become dormant. The infected branch traces which become overgrown and incorporated into the main stem are the sites of inital decay following wounding of the tree. Infections are apparently activated only within several inches of the wound.

MANAGEMENT RECOMMENDATIONS

A variety of pest problems are present in many stands in the West Red area. Some diseases are causing severe problems. Most stands in need of treatment

are affected by more than one pest. A brief recommendation is included with each stand review. These recommendations were made on the basis of pest damage and viable silvicultural options.

Laminated Root Rot

Phellinus weirii infected stands are usually best treated by regenerating diseased areas to species less susceptible to damage. Another alternative, inoculum removal by stump pulling, is available but, because of environmental disturbances and expense, it is generally less desirable.

Portions of stands in disease centers should be delineated on the ground prior to stand harvest. Knowledge of disease location can be useful in determining unit boundaries and also in establishing and managing the next stand on the site. FPM is available to do this work in stands selected for harvest. Treatment areas should extend 50 feet beyond the last live tree exhibiting crown symptoms on the edge of centers. If the harvest unit extends beyond edges of disease centers, fellers should be asked to watch for and mark surfaces of any additional infected stumps they may find.

Stands with disease centers should be harvested using a regeneration-type system. Clearcutting or a seedtree/shelterwood may be used. Any type of partial-cut system would require less-susceptible species such as western white pine, western larch, ponderosa pine and possibly western hemlock to be abundant, well distributed, and producing seed. If dwarf mistletoe-infected trees are to be used, they should be removed or girdled before regeneration is 3 feet tall or ten years old. When planting is required, diseased areas and buffers 50 feet beyond infected stumps should be planted to less-susceptible tree species. During stocking control entries, natural regeneration of Douglas-fir and grand fir should be removed from centers.

Western larch, which normally is less-susceptible to P. weirii than Douglas-fir, was displaying resistance in most diseased centers, but was being severely damaged in several areas. Affected trees were usually mature. Reasons for this difference in damage are not clear but it is advisable not to manage larch on rotations of more than 100 years on sites where it had been adversely affected.

White pine blister rust (Cronartium ribicola), was not observed affecting white pines in the West Red area. This may be because of the low number of white pine seen. On some sites this species may be used to regenerate laminated root rot pockets. Prior to selecting planting stock it is advisable to rate the sites for blister rust hazard. Since rust resistant white pine are in short supply, it is important to use planting stock which match the level of resistance needed for the site. FPM personnel are available to provide this assistance.

Management of True Firs

In the West Red Planning Area, Armillaria root disease was found causing its most serious damage to true fir. Other pests causing considerable damage to true firs are Indian paint fungus and Annosus root rot. Management of true firs is difficult because of their susceptibility to root diseases, stem decay, and attack by insects.

Some stands in the survey have numerous declining true firs which are overmature, decadent and/or have been damaged in past partial-cut entries. In most cases these true firs were left when more valuable species were harvested.

Most stands having had such treatment are declining. Stands that had considerable residual wounding and disturbance are in the worst condition. Annosus root rot and, in some cases, Armillaria root disease, will cause increasing levels of damage in these stands. Indian paint fungus will also increase in severity. Continued management of these stands will encourage predominantly true fir understories to develop which, in turn, will be impacted by intensifying disease levels.

We strongly recommend that the most severely damaged true fir stands be converted to predominantly seral species such as ponderosa pine and western larch and, where laminated root rot does not occur, Douglas-fir. The worst stands should be treated in the next scheduled entry. In future entries, similar stands should be identified and treated. Usually, treatment, including a regeneration harvest, will be needed. In some stands, residuals of desired seed trees may occur at stocking levels required to regenerate portions, if not all, of the treatment blocks.

Some stands of vigorous healthy young true fir occur which should be managed to maturity. Successful management of such stands requires more care than is exercised in stands dominated by less disease-susceptible species. Generally, intermediate entries should be avoided to minimize soil damage and crop tree scarring. Where commercial thinning is to be done, care should be taken in planning and actual logging to reduce damage. On sites where true firs are to be managed in the future, large stumps (>18 inches in diameter), should be treated with sodium tetraborate decahydrate (borax) as described in FSM 2331.31.

True fir should be managed on relatively short rotations (120 years or less). In making decisions of where true fir advanced regeneration can be managed following an overstory removal, ages of overstory and understory true fir should be considered. Understory true firs that have been suppressed for 50 years or more are not good risks for management. Presence of overstory trees more than 120 years old indicate that understory trees are at a greater risk to damage by Indian paint fungus and Armillaria root disease than if the overstory were younger.

Dwarf Mistletoes

Several dwarf mistletoes are damaging stands in this area. Douglas-fir and western larch dwarf mistletoes are, by far, the most serious. Dwarf mistletoe infested stands can be treated by reducing or eliminating the mistletoe-infected trees of a given species and managing the remaining healthy trees. In more extreme cases, infected stands can be clearcut and regenerated with precautions taken to minimize potential for reinfection. Another method of management is to remove infected trees, providing growing space to manage a tree species which is not being affected by dwarf mistletoe.

The most serious dwarf mistletoe problems develop in multi-storied stands where infections perpetuate and intensify by spread from overstory to understory trees. Conversion of stands to a single-story structure is the most important step in reducing impact.

The following recommendations are made for stands infected with Douglas-fir or larch dwarf mistletoes:

1) Locate treatment block boundaries so that potential for reinvasion is minimized. This using utilizing topographical and man-made features to isolate treatment areas from infected timber.

2) Remove infected overstory trees. Light to moderately infected trees may be retained in a seed tree/shelterwood harvest if they are removed before the regeneration is 3 feet tall or 10 years old.

The following recommendations are specific for Douglas-fir:

1) Remove visibly infected understory and all saplings and poles within 50 feet of an infected overstory since they probably have undeveloped latent infections.

2) Lightly infected stands which are near merchantability standards should be retained until they can be harvested.

3) Thinning of the understory should not be done unless few latent infections are anticipated and crop trees have no visible infections.

4) Other species, such as ponderosa pine and western larch, should be favored in young stands affected with Douglas-fir dwarf mistletoe.

The following recommendations are specific for western larch:

1) Lightly-infected sapling to pole-sized trees with good live crown ratios should respond to thinning. Stocking whould be reduced to a level that will allow healthy crop trees to release; tree height growth should exceed the upward spread rate of mistletoe.

2) Dwarf mistletoe impact should be monitored in thinned stands. When losses become apparent, the stand should be re-entered for a seedtree/shelterwood treatment. Resulting regeneration should be released from the overstory before it is 3 feet tall or 10 years old.

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